# Avian Nest Success in Growing and Dormant Season Burned Pine Forests of Georgia

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*Abstract:* Prescribed fire is a commonly used land management tool in pine (*Pinus* spp.) forests of the southeastern United States to control understory vegetation and enhance wildlife habitat for early successional species, but its effects on the nesting success of understory and ground-nesting songbirds are not well understood. We compared the effects of growing and dormant-season prescribed burns on the nesting success of six ground- or shrub-nesting bird species in mature pine stands at one and two years post-treatment at Fort Benning Military Reservation in Chattahoochee and Muscogee counties, Georgia, during 1995 and 1996. Apparent nest success did not differ between burn treatments during both years for eastern towhees (*Pipilo erythrophthalmus;* $P = 0.37$, $P = 0.21$), indigo buntings (*Passerina cyanea*; $P = 1.0$, $P = 1.0$) and yellow-breasted chats (*Icteria virens*; $P = 0.64$, $P = 0.69$). For Bachman's sparrows (*Aimophila aestivalis*; $P = 0.052$) and northern cardinals (*Cardinalis cardinalis;* $P = 0.055$) there were no differences in 1995, but insufficient data existed in 1996 for comparisons. However, growing season apparent nest success was higher than dormant season for prairie warblers (*Dendroica discolor*) 1995 ($P = 0.04$), but not in 1996 ($P = 0.24$). Our results suggest negligible differences in songbird reproductive success in response to growing-season prescribed burns.

*Key words:* fire, Mayfield, nest, songbird, success

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Fire was instrumental in shaping Pre-Columbian forest communities of the southeastern United States. Natural fires historically occurred during the growing season when dry conditions facilitated lightning-set fires (Landers 1987, Robbins and Myers 1992). However, Native Americans likely used fire throughout the year to meet their own objectives for persistence (Van Lear et al. 2005). Native Americans prior to European and Spanish colonization used fire for fuel and pest reduction, wildlife and forest management, and tribal protection (Carroll et al. 2002). At the time of the study, most prescribed burns in the Southeast were initiated during the dormant season or early growing season (April-May) to minimize wildfire potential. Some land managers still use these fires as habitat management for early successional species (Landers 1987, Robbins and Myers 1992, Richardson and Stockie 1995, Shriver et al. 1996). Nearly 3.2 million ha of pine (*Pinus* spp.) forested land is prescribe burned annually in the southeastern United States for understory vegetation reduction, inexpensive site preparation for replanting, and promotion of wildlife habitat (Dickson 1981, Komarek 1981, Wade and Lunsford 1989).

In the southeastern United States, some avian species use fire-maintained pine uplands exclusively (Stoddard 1931, Ligon et al. 1986, Wood et al. 2004). Habitat specialists like the endangered red-cockaded woodpecker (*Picoides borealis*) are dependent on mature pine stands for nesting and roosting cavities (Hooper et al. 1980). In addition, several ground- and shrub-nesting songbirds are common in fire-maintained pine habitats, including species listed by Partners in Flight as priority such as common yellowthroats (*Geothlypis trichas*), indigo buntings (*Passerina cyanea*), prairie warblers (*Dendroica discolor*), yellow-breasted chats (*Icteria virens*), and Bachman's sparrows (*Aimophila aestivalis*) (Johnston and Odum 1956, Wilson et al. 1995, King 1997, Tucker et al. 2004).

Growing-season burns are generally thought to be effective in suppressing hardwood understories (Waldrop et al. 1992). Such fires may affect habitat structure and vegetation responses which could affect nesting activities of ground- and shrub-nesting species (Dickson 1981, Landers 1987, Petersen and Best 1987). Few studies have examined the effect of fire season on ground- and shrub-nesting avian populations, although Tucker et al. (2004, 2006) found little evidence to suggest that season of fire has an effect on Bachman's sparrow abundance or productivity. However,

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other shrub-nesting species may be more affected by the season of burn.

Season of fire is one variable that affects the potential response of birds. Season interacts with the scale or extent of the area burned and the frequency that fire is applied. We only investigated one key variable, season, and recognize that other variables would likely be important to consider. Since the time of our study, the management of the study site has stayed consistent with that described here.

We compared the nesting success and clutch sizes of six ground or shrub-nesting species between growing and dormant-season burned areas one- and two-years post-burn. We defined dormant-season burns as those conducted during January through March, and growing season as those conducted during April through August.

## Methods

This study was conducted on the 74,500-ha Fort Benning Military Reservation (FBMR) in Chattahoochee and Muscogee counties, Georgia. Fort Benning is situated on the fall line dividing the Piedmont and Upper Coastal Plain physiographic regions. Approximately 60% of FBMR's forested landscape consists of loblolly (*Pinus taeda*), longleaf (*P. palustris*) and shortleaf (*P. echinata*) pine forests; remaining habitats are comprised of pine-hardwood and bottomland hardwood forests. The midstory of the pine stands consists of sweetgum (*Liquidambar styraciflua*), flowering dogwood (*Cornus florida*), and various oak species (*Quercus* spp.) and the understory vegetation is primarily bluestems (*Andropogon* spp.), blackberry (*Rubus* spp.), gallberry (*Ilex glabra*), blueberries (*Vaccinium* spp.), and various forbs.

We selected study sites within the fire-maintained pine habitats of the Army installation. Random sites were not logistically feasible because of safety concerns. Furthermore, plot selection was limited to areas that were planned for burns according to the installation management plan. Our focus was not to investigate the effects of RCW management on nest success; however, our plots did fall within areas managed for RCW. We chose nine sites that were burned during the 1994 growing-season (April-August) and nine sites that were burned during the 1994 dormant season (January-March). Each site was approximately 10 ha. Four growing- and one dormant-season study sites were destroyed by wildfires between the first and second year post-burn and were excluded from nest searching the second year.

From late April through early July 1995 and 1996, each site was searched for nests for three hours each week. Nest search effort was constant between dormant and growing season plots. Nests were checked every three to four days until a nesting outcome (Murphy 1983, Martin and Roper 1988). A nest was considered successful if >1 of the species fledged. We assumed nest failures occurred midpoint between the final two visits. Daily nest survival was calculated by Mayfield's exposure method (Mayfield 1961, 1975). We compared apparent nest success between growing-and dormant-season burns for each species using Fisher's Exact $\chi^2$ test. Data were not pooled between one- and two-years post-burn because we wanted to detect differences between years. Student's two-sample *t*-test was used to compare the number of eggs laid and young fledged per successful nest between growing and dormant-season prescribed burn sites for each species.

Stand vegetation measurements were taken at nine random points (0.04 ha) at each study site during July and August 1995 and 1996. Measurements included stand age, basal area, canopy closure, shrub density, vegetative ground cover, and vegetation profile. Vegetative profile was measured using a 0.5 x 3 m density board situated 11.3 m from the center point (Noon 1981). Analysis of variance was used for vegetation comparisons between burn treatments and years. The average of the nine points for each study site was used as the site value for each vegetation variable.

## Results

Growing- and dormant-season burned areas had similar vegetation characteristics and profile (Table 1). Ground cover was

**Table 1.** Mean vegetation characteristics (± SE) of growing and dormant-season prescribed-burned mature pine stands at one-year (1995) and two-year (1996) post-burn on Fort Benning Military Reservation, Georgia.

| | 1995 | | | 1996 | | |
|---|---|---|---|---|---|---|
| **Habitat characteristic** | **Growing (*n* = 9)** | **Dormant (*n* = 9)** | ***P*-Value** | **Growing (*n* = 5)** | **Dormant (*n* = 8)** | ***P*-value** |
| Stand age[a] (years) | 51.6 (4.34) | 57.7 (3.97) | 0.31 | | | |
| Snag density[a] (*n*/0.04 ha) | 29.1 (19.0) | 37.2 (28.6) | 0.49 | | | |
| Basal area[a] ($m^2$/acre) | 4.6 (.53) | 5.4(.7) | 0.35 | | | |
| Canopy closure[a] (%) | 31.7 (0.85) | 31.0 (0.77) | 0.56 | | | |
| Shrub density (*n*/0.04 ha) | 10.2 (0.76) | 8.2 (0.76) | 0.45 | 15.1 (1.57) | 13.4 (1.18) | 0.73 |
| Vegetative ground cover (%) | 6.3 (0.14) | 5.0 (0.15) | 0.04 | 6.5 (0.37) | 5.7 (0.15) | 0.30 |
| Vegetation profile (%) | | | | | | |
| 0.0–0.5 m | 58.8 (1.94) | 48.1 (1.99) | 0.15 | 64.4 (2.85) | 56.4 (2.39) | 0.26 |
| 0.5–1.0 m | 36.1 (2.14) | 30.6 (2.03) | 0.41 | 44.7 (3.11) | 38.9 (2.52) | 0.48 |
| 1.0–1.5 m | 18.9 (1.70) | 17.7 (1.60) | 0.79 | 25.7 (2.72) | 23.5 (2.11) | 0.72 |
| 1.5–2.0 m | 13.3 (1.46) | 15.5 (1.61) | 0.57 | 23.3 (2.66) | 20.4 (2.02) | 0.59 |
| 2.0–2.5 m | 11.2 (1.38) | 11.7 (1.38) | 0.90 | 20.1 (2.49) | 14.3 (1.67) | 0.30 |
| 2.5–3.0 m | 11.7 (1.51) | 10.6 (1.34) | 0.74 | 16.9 (2.25) | 14.6 (1.77) | 0.66 |

a. Measurements only taken in 1995.

greater in growing-season burned areas ($P = 0.04$), although likely not biologically significant. We found 264 nests of six species: 120 in one-year post-burn sites and 144 in two-year post-burn sites. The species included in our analysis were Bachman's sparrow, eastern towhee (*Pipilo erythrophthalmus*), indigo bunting, northern cardinal, prairie warbler, and the yellow-breasted chat because these species represented several guilds of birds. In the first year, we found 6.1 nests per growing-season burned site and 8.3 in dormant season sites. At two-year post-burn, we found a mean of 12.0 nests per growing season and 10.5 for the dormant season burned plots.

Apparent nest success did not differ between burn treatments during both years for eastern towhees ($P = 0.37$, $P = 0.21$), indigo buntings ($P = 1.0$, $P = 1.0$) and yellow-breasted chats ($P = 0.64$, $P = 0.69$). For Bachman's sparrows ($P = 0.052$) and northern cardinals ($P = 0.055$) there were no differences in 1995, but insufficient data existed in 1996 for comparisons. However, growing season apparent nest success was higher than dormant season for prairie warblers in 1995 ($P = 0.05$) but not in 1996 ($P = 0.25$).

Clutch sizes for all species of successful nests in one-year post-burn sites did not differ for any bird species regardless of treatment (Table 2). In the second-year post-burn, successful clutch sizes for yellow-breasted chats were greater ($P = 0.02$) in growing-season burn regimes than in dormant-season burned areas. The number of nestlings per successful nest did not differ for any species except for the prairie warbler, which produced more nestlings in growing-season prescribed burn sites one-year post-burn ($P = 0.02$) than in dormant-season burned areas. No differences were found for numbers of nestlings in successful nests for all species two-years post-burn. The number of fledglings for successful eastern towhee nests was greater ($P = 0.01$) in dormant-season burn regimes one-year post-burn than growing-season burned areas. The number of fledglings per successful nest for all species did not differ between treatments one-year and two-years post-burn.

## Discussion

Although prescribed fire in pine forests promotes suitable habitat for many bird species (Cram et al. 2002, Engstrom et al. 2005, Tucker et al. 2006), there are few studies that examine the effects of season of burn on avian populations. Habitats that were burned during the growing season did not affect avian abundances in Florida (Tucker et al. 2006, Walsh et al. 1995); whereas indigo bunting, prairie warbler and Bachman's sparrow abundances increased in response to growing-season fires in Oklahoma (Wilson et al. 1995). In a study comparing avian responses to season of burn, abundances of prairie warblers, common yellowthroats, eastern towhees, indigo buntings, yellow-breasted chats, and mourning doves (*Zenaida macroura*) were greater in growing-season burned areas in Georgia (King 1997), while dormant-season burned areas supported greater abundances of pine warblers (*Dendroica pinus*), yellow-throated vireos (*Vireo flavifrons*), and blue-gray gnatcatchers (*Polioptila caerulea*).

**Table 2.** Reproductive success for six avian species between growing-season (GSPF) and dormant season (DSPF) prescribed fire regimes one-year (1995) and two-year (1996) post-burn at Fort Benning Military Reservation, Georgia.

| | Bachman's sparrow | | Eastern towhee | | Northern cardinal | | Indigo bunting | | Prairie warbler | | Yellow-breasted chat | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **GSPF** | **DSPF** | **GSPF** | **DSPF** | **GSPF** | **DSPF** | **GSPF** | **DSPF** | **GSPF** | **DSPF** | **GSPF** | **DSPF** |
| **1995** | | | | | | | | | | | | |
| Total nests[a] | 5 | 5 | 7 | 13 | 8 | 13 | 14 | 9 | 12 | 13 | 9 | 12 |
| Mean clutch size | 4.0 (4; 0.4)[b] | 4.0 (2; 0.0) | 3.0 (2; 0.0) | 3.4 (7; 0.4) | 2.9 (8; 0.1) | 3.2 (7; 0.2) | 3.4 (9; 0.2)[b] | 3.2 (5; 0.4) | 3.9 (8; 0.1) | 3.7 (3; 0.3) | 3.4 (7; 0.2) | 3.4 (7; 0.4) |
| Young fledged/ successful nest | 4.0 (4; 0.4) | 2.5 (2; 0.5) | 0.0 (2; 0.0) | 2.6 (7; 0.4) | 2.3 (8; 0.3) | 2.4 (7; 0.3) | 3.2 (9; 0.3) | 2.4 (5; 0.4) | 3.8 (8; 0.2) | 3.0 (3; 0.6) | 3.0 (7; 0.3) | 2.3 (7; 0.5) |
| Daily survival rate % | 0.98 (59.5)[c] | 0.94 (46.5) | 0.95 (101) | 0.97 (201.5) | 1.0 (133) | 0.97 (192.5) | 0.96 (199.5)[c] | 0.96 (101.5) | 0.98 (186.5) | 0.94 (177.5) | 0.98(121) | 0.96 (122.5) |
| $\chi^2$ Test[d] | $\chi^2 = 1.6667$ | $P = 0.52$ | $\chi^2 = 1.1744$ | $P = 0.3742$ | $\chi^2 = 4.4444$ | $P = 0.055$ | $\chi^2 = 0.1753$ | $P = 1.0$ | $\chi^2 = 4.8119$ | $P = 0.0472$ | $\chi^2 = 0.8750$ | $P = 0.6424$ |
| **1996** | | | | | | | | | | | | |
| Total nests[a] | 1 | 2 | 8 | 16 | 3 | 7 | 15 | 16 | 20 | 31 | 13 | 12 |
| Mean clutch size | N/A[e] | N/A | 3.5 (2; 0.5) | 3.1 (9; 0.1) | N/A | 2.8 (4; 0.3) | 2.6 (6; 0.2) | 3.0 (7; 0.2) | 3.8 (9; 0.1) | 3.8 (20; 0.1) | 4.0 (6; 0.0) | 2.5 (4; 0.6) |
| Young fledged/ successful nest | N/A | N/A | 2.5 (2; 0.5) | 2.3 (9; 0.3) | N/A | 2.5 (4; 0.3) | 2.3 (6; 0.3) | 2.0 (7; 0.3) | 3.0 (9; 0.3) | 3.2 (20; 0.3) | 3.3 (6; 0.3) | 2.0 (4; 0.7) |
| Daily survival rate % | N/A | N/A | 0.98 (99.5) | 0.96 (171) | N/A | 0.96 (122.5) | 0.99(182.5) | 0.96 (201) | 0.95 (201.5) | 0.96 (250.0) | 0.95 (142) | 0.95 (165.5) |
| $\chi^2$ Test | | | $\chi^2 = 2.0979$ | $P = 0.2108$ | | | $\chi^2 = 0.0447$ | $P = 1.0$ | $\chi^2 = 1.887$ | $P = 0.2477$ | $\chi^2 = 0.4274$ | $P = .6882$ |

a. The number of nests were pooled across all plots for each treatment for each species.
b. Sample size and standard error.
c. Number of exposure days.
d. Fisher's exact $\chi^2$ test was used to compare apparent nest success between treatments for each species.
e. Not available

Vegetation responses from fire likely have the greatest impact on nest success by affecting the degree of nest concealment. Dormant-season burns usually are considered fuel-reducing fires, leaving many hardwood stems and maintaining a shrub understory. Growing-season fires may suppress hardwood vegetation and create more open understories with decreased vertical structure that favors ground nesting species (Waldrop et al. 1992). Season of burn can dictate the type of habitat produced; however, several decades of regular burning may be necessary to create habitats indicative of growing-season or dormant-season fires (Waldrop et al. 1992). Because the use of growing-season fire on FBMR was limited before the initiation of our study, season of burn effects on vegetation were not detectable given our sampling protocol. We suspect that continual use of growing season fire would result in a biological difference in vegetation as it relates to grassland and shrubland birds. The perceived unchanged vegetation conditions between the treatments would support little to no change in apparent nest success between the treatments.

We found little evidence that overall production of songbirds was affected by growing-season burns. This is important because managers and biologists have expressed concerns of a decrease in reproductive success with growing-season burns. Although our data set and inferences have limitations, we feel there is support for growing season burns as a management tool in the pine forests of the southeastern United States.

Today an emphasis is placed on ecosystem level management; forest managers must develop effective burning schedules to meet those objectives. Using various seasons of fire can be used to meet goals set by managers (Engstrom et al. 1996). Apparent nest success for avian species in fire-maintained pine communities in Georgia either benefitted from or was not affected by growing-season prescribed fires. However, we did not investigate the effects of dormant or growing season fires within the same year as they occurred. Nevertheless, we believe that our investigation provided evidence of the neutral effects of growing season fire on apparent nest success of the songbird species we examined.

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